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NONPROVISIONAL PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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BOX PATENT APPLICATION

NONPROVISIONAL APPLICATION TRANSMITTAL
RULE §1.53(b)

Director of the U.S. Patent and Trademark Office
 Washington, D.C. 20231

Sir:

Transmitted herewith for filing under 37 C.F.R. §1.53(b) is the nonprovisional patent application

For (Title): MEASUREMENT APPARATUS INCLUDING A TRACK FOR A MEASUREMENT
 SCALE AND APPARATUS FOR TENSIONING THE SCALE

By (Inventors): James Reynolds HENSHAW, Peter Geoffrey HOLDEN, Richard John HOODLESS,
 Thomas Ian MACKINTOSH, and David Roberts MCMURTRY

- ☒ Formal drawings (Figs. 1-17; 7 sheets) are attached.
☒ A Declaration and Power of Attorney is filed herewith.
☒ An assignment of the invention to Renishaw plc is filed herewith.
☒ An Information Disclosure Statement is filed herewith.
☐ Entitlement to small entity status is hereby asserted.
☐ A Preliminary Amendment is filed herewith.
☐ Please amend the specification by inserting before the first line the sentence --This nonprovisional application claims the benefit of U.S. Provisional Application No. _____, filed _____.--
☒ Priority of foreign applications No. 9928098.4 filed November 30, 1999 in United Kingdom and No. 0013141.7 filed May 31, 2000 in United Kingdom are claimed (35 U.S.C. §119).
☒ A certified copy of the above corresponding foreign applications is filed herewith.
☒ The filing fee is calculated below:

CLAIMS IN THE APPLICATION AFTER ENTRY OF
ANY PRELIMINARY AMENDMENT NOTED ABOVE

FOR:	NO. FILED	NO. EXTRA
BASIC FEE		
TOTAL CLAIMS	18 - 20	= 0
INDEP CLAIMS	4 - 3	= 1
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIMS PRESENTED		

* If the difference is less than zero, enter "0".

SMALL ENTITY

RATE	FEE
	\$ 355
x 9 =	\$
x 40 =	\$
+ 135 =	\$
TOTAL	\$

OR

OR

OR

OR

OR

OR

OTHER THAN A
SMALL ENTITY

RATE	FEE
	\$ 710
x 18	\$
x 80	\$ 80
+ 270	\$
TOTAL	\$ 790

- ☒ Check No. 114072 in the amount of \$790 to cover the filing fee is attached. Except as otherwise noted herein, the Director is hereby authorized to charge any other fees that may be required to complete this filing, or to credit any overpayment, to Deposit Account No. 15-0461. Two duplicate copies of this sheet are attached.

Respectfully submitted,

James A. Oliff
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MEASUREMENT APPARATUS INCLUDING A TRACK FOR A
MEASUREMENT SCALE AND APPARATUS FOR TENSIONING THE
SCALE

5 **Field of the Invention**

The present invention relates to a track arrangement for carrying a measurement scale for use in scale, a scale therefor, and to apparatus and a method for tensioning a measurement scale.

10

Description of the Prior Art and Summary of the Invention

A known form of opto-electronic scale reading apparatus for measuring relative displacement of two members comprises a length of scale on one of the members, 15 having scale marks defining a periodic pattern, a read head provided on the other member, means for illuminating the length of scale, periodic diffraction means for interacting with light from the scale marks to produce interference fringes having movement relative to the read head and detecting means in the read head responsive to the fringes to produce a measure of the displacement.

20

An example of such apparatus is disclosed in EP-A-0 207 121 and also US-A-4,974,962. Typically, the length of scale could be of spring steel with a surface layer of copper. US-A-4,926,566 discloses a method of producing a length of scale, in the form of a flexible tape produced by rolling, the pitch of the scale marks being 25 20 μm or 40 μm for example.

Conventionally the length of scale may be carried by being received by a track, for example comprising an aluminium extrusion, the lower part of the track being attached to a surface, for example by screws or bolts, and the upper part of the track 30 being formed to receive the length of scale - see Fig. 1 which is a section through a length of track 1 which is attached to a surface 2 by screws 3 spaced apart along its

length and lengths of clamping strip 4, the upper part of the track 1 receiving a length of scale 5 which has been slid into it.

5 The upper part of the track 1 has scale holding elements 1a for keeping the scale in place.

However, such an arrangement can be difficult to make and to install. The small ride-height tolerance of a typical read head means that the track 1 requires accurate manufacture. The necessary clearance for the sliding fit of the scale 5 in the track 1
10 demands that the scale be manufactured even more accurately to compensate for this clearance.

It is not desirable to clamp the scale 5 securely to the track 1 because there may be relative thermally induced movement between the scale and track, particularly if
15 dissimilar metals are used. For this reason the prior art track shown in Figure 1 allows sliding movement of the scale. The scale will produce more accurate readings if it is held at a fixed position, both lengthwise and laterally but should not be clamped to the track, and should not be subjected to any deviations in the forces holding it in position.

20 According to one aspect of the present invention there is provided an elongate track comprising a channel, the channel being adapted for holding a measurement scale therein, wherein the track is adapted for attracting magnetically the scale to the channel of the track.

25 The track could have magnetic material (for example a length of flexible magnetic material such as ferrite rubber) for holding the scale magnetically. In this case, the length of magnetic material could be in the channel of the track, the scale being above the length of magnetic material, for example sitting on edge portions (which are, for
30 example, below the upper surface of the track) along respective sides of the channel.

The track could be attached to the surface by screws passed through holes in it. Such holes could be at the bottom of the channel or in the track alongside such a channel.

The track could be machined or an extrusion, for example an aluminium extrusion.

5

Alternatively the track could be a length of magnetic material for example ferrite rubber, having the channel formed integrally therein.

The invention extends to a track and scale therefor.

10

It has been found that the scale may lift from a track or similar support under conditions where it is under compression. The present invention according to a second independent aspect relates to a scale tensioner, an embodiment of which prevents lifting of a scale.

15

One scale tensioning device is described in US 4559707 (Heidenhain). However this and other scale tensioners are directed to correcting errors in the scale's pitch rather than to prevent lifting.

20

The constructional details of these prior art tensioners differ from the proposed invention which provides a measurement scale tensioning device comprising a preloadable resilient member operable to urge the scale into tension.

25

The device may include a resilient member loading part operable to preload the member and operable to release the load.

The invention according to yet another aspect provides a method of tensioning a measurement scale, comprising the following steps:

30

- providing a measurement scale, and scale tensioner;
- preloading the scale tensioner;
- mounting the scale to a substrate;

releasing the preload in the tensioner to cause a tension in the scale; and
securing the said other end of the scale to the substrate whilst maintaining the
5 tension in the scale.

10 The invention extends to a method for tensioning and if necessary repeating the tensioning.

15 The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Fig 2 is a plan view of a length of track forming a first embodiment of the invention according to the first aspect of the invention;

Fig 4 is a section through the length of track and showing a screw through a hole in it;

25 Fig 6 is a section through a wider form of track;

Fig 8 is a plan view of a length of track forming a further embodiment of the invention;

Fig 10a) is a section through A-A of Fig 9, Fig 10b being an enlarged view of part of Fig 10a);

Fig 11 shows means for fixing lengths of track end to end;

Fig 12 is a sectional view of another type of track forming another embodiment of the invention;

Fig 13 is a sectional view of yet another type of track forming yet another embodiment of the invention;

Figs 14&15 show a plan and side view respectively of a scale tensioning device according to the second aspect of the invention;

Fig 16 is an enlarged partial view in the direction of arrow "X" in Fig 14; and

Fig 17 is an isometric view of the tensioning device, scale and scale track shown in Figs 14,15 and 16.

Description of the preferred embodiments

Referring to Figs 2-5, a length of aluminium extrusion provides a length of track 6 attachable to a surface by screws 7 passed through holes 8 spaced apart (for example with a pitch of 10cm) along the length of track 6. The length of track 6 is formed with a channel 9 running centrally along its length, the holes 8 being at the bottom of the channel 9. Also, along each side of the channel 9 is an edge portion 10 below the upper surface of the length of track 6.

With lengths of track 6 attached to a surface by screws 7, between each pair of holes 8 there is laid a strip 11 of flexible magnetic material, held on to the bottom of the channel 9 by a strip 12 of double-sided adhesive tape. By way of example, the strips 11 could be strips of ferrite rubber such as that provided by Magnet Applications Limited, of Northbridge Road, Berkhamsted, Hertfordshire HP4 1EH, England. Then, a length of scale 5 (for example for use in opto-electronic scale reading apparatus) is laid on to the edges 10 and held magnetically in place on the track 6 by the strips 11 of flexible magnetic material.

Fig 6 shows a section through a wider length of track 6 for use in the arrangement of Fig 7 in which a read head carried by a sprung read head carriage 13 runs on the

length of track 6. A wheel 14 is fixed via a bracket to the read head carriage 13 and the assembly sprung towards the scale 5. The wheel runs on the length of track 6, maintaining the correct scale to read head gap substantially irrespective of undulations and steps in the surface to which the length of track 6 is attached.

5

In the above embodiments, the length of track 6 is formed with a channel 9 running centrally. Referring to Figs 8, 9, 10a and 10b an alternative form of length of track 6a comprises an aluminium extrusion formed with holes 8a spaced apart along its length for attaching the track 6a to a surface by screws, the holes being offset from the longitudinal centre line of the length of track 6a. Also offset from the centre line is a channel 9a along each side of which there is an edge 10a. In use, the length of track 6a is attached to a surface, a strip of flexible magnetic material is held on to the bottom of channel 9a by a strip of double-sided adhesive tape and a length of scale is laid on to the edges 10a and held magnetically in place by the strip of flexible magnetic material. Such a structure may be used, like with the Fig. 7 embodiment, with a sprung read head carriage to which a wheel is attached, the wheel running on the upper surface of the length of track 6 alongside the channel 9a.

Such lengths of track 6 or 6a may be placed end to end with a small (~0.5mm) clearance. This is satisfactory unless the surface to which they are attached is uneven. A solution is to make each end of such a length of track as shown in Fig 11 so two ends plug together by virtue of dowels 15 and holes 16. In practice this could be achieved with two keyhole slots open at the bottom, a suitable dowel-pin being fixed in one of the holes. This enhancement would be particularly useful when used in conjunction with a sprung read head carriage.

The scale may take the form shown in Fig 12. In this embodiment an aluminium extrusion 20, having the profile shown, is used as a scale supporting track. The extrusion 20 has a channel 22 for accommodating heads of securement screws etc which pass through holes 24, shown in hidden detail. A further channel 26 is illustrated. Like the other embodiments this channel 26 accommodates a scale 5 and a

magnetic strip 11 for holding the scale in place. The strip is held in place by means of adhesive.

5 It will be noted that there is a slight concavity 28 to the underside of the track. The purpose of the concavity is to ensure that the underside stays in register with the surface to which it is mounted, and does not form a convexity. A convexity would allow the track to rock on the surface, and thereby reduce control of the height of the scale.

10 In the above embodiments, the magnetic force holding the length of scale in place should not be greater than necessary since it is useful to minimise sliding frictional force between scale and track. This is achieved by the choice of air gap between the scale and the magnetic material.

15 Fig 13 shows yet another embodiment of the track. In this embodiment a flexible magnetic strip 30 is used to hold the scale 5. The strip is formed from ferrite rubber of the type mentioned above. A channel 32 is formed in the track 30 for holding the scale 5 and provides lateral support for the scale. This track may be held magnetically to a ferrous substrate e.g. a cast iron machine tool bed. In use the track may be
20 temporarily positioned for, say commissioning of the machine and then removed.

A variant (not shown) of the track shown in Fig 13 has a channel slightly wider than the scale to ensure that any radii at the internal corners of the channel do not lift the scale and distort its height.

25 The tracks shown in Figs 12 and 13 may be employed in a manner similar to manner of use of the other tracks described above.

30 It will be appreciated that the present invention may be used with scale and scale reading apparatus other than the opto-electronic type – for example scale and reading apparatus which operates by means of magnetic or capacitive detection can be used.

2 1 9

5 The scale may be magnetised or may have a magnetic strip affixed thereto for co-
operation with a magnetic or magnetised part of the track. The scale may gain its
magnetic attraction from the substrate to which the track is attached, e.g. the scale
may be magnetic and in use is positioned in close proximity (within the channel) to a
ferrous substrate like cast iron.

10

Referring to Figs 14,15,16 and 17 there is shown a scale tensioner which may be used e.g. to tension any of the scales described above. The tensioner is illustrated with a track similar to that shown in Figs 8,9,10a&10b, although a track of any type might be used and in its broadest sense the invention according to the second aspect need not use a track. Tension in the scale prevents the possibility of compression and lifting of the scale.

15

There is shown a length of track 6 and a scale 5. The scale is secured at each end to a substrate 66 e.g. a machine tool bed. Two clamps, one for each end of the scale, each have two parts 42 and 44. The scale is sandwiched and held between these two parts. The two clamps are secured to the substrate 66 by means of screws. The track 6 illustrated is secured to the substrate also, by means of screws extending through holes 46 in the track 6.

20

The tensioner comprises a main body 40 having a resilient coil spring 54 housed therein. The spring abuts a plunger 56. The spring 54 is compressible within the body 40 to provide a preload and is held in a compressed state by means of an eccentric pin 52 acting to prevent movement of the plunger 56. The pin 52 is rotatable with shaft 50. The shaft 50 has a slot 62 for manual turning of the shaft e.g. with a screwdriver.

25

30 The body 40 is securable adjustably using clamp screw 68 to the support 60 which is in turn securable to the substrate via one of the holes 46 normally used to secure the

track to the substrate 66, using bolt 70. Adjustment of the position of the body 40 relative to the support 60 is achieved by means of a slot 48 in the body through which the clamp screw 68 may pass.

- 5 In use the scale and track are mounted to the substrate 66, and the two end clamps 42 and 44 are attached to the scale. One end clamp is secured to the substrate (holding the scale) and the other is loosely attached to the substrate (again holding the scale). Support 60 is secured to the substrate via the track mounting holes 46 and the tensioner body 40 is attached to the support and slid toward the loose end clamp i.e.
- 10 the clamp shown in the Figures. The body 40 in its preloaded state is then tightened to the support.

- The body is initially in the condition shown in Fig 16 i.e. pin 52 holds back the plunger 56 against the force of the spring 54. Slot 62 in the shaft 50 is turned through
- 15 180° which moves the pin in an eccentric manner away from the plunger 56. This action releases the tension in the compressed spring and forces the plunger against clamp part 42 (at the abutment point 64 shown in Fig 16).

- The clamp part 42 is attached to the scale 5 so the scale will be forced into tension.
- 20 The loose clamp can be tightened to the substrate and the body 40 and support 60 can be removed. The scale will remain in tension. The now vacant track securement holes can be used to secure the track.

- The preload in the spring is adjustable e.g. to give a correctly calibrated tensioning
- 25 force. A screw 66 is used to adjust the tension in the spring to give the correct tension in the scale when the plunger is released. It is envisaged that the spring will produce a tension force in the order of 10 to 40 N.

- The process of scale tensioning may need to be repeated, particularly when a long
- 30 scale is being tensioned. Long scales will stretch further than short ones when

subjected to the same tension, so the stroke of the pin 52 may be insufficient to induce the required tension in the scale.

In such circumstances the spring 54 can be compressed again by turning shaft 50 and the body 40 can be repositioned to abut once more clamp part 42 at abutment 64. The scale clamp is loosened. The preload in the spring 54 is released by turning the shaft 50 and the scale is thereby tensioned once more.

The clamp is then tightened to the substrate.

10

The process may be repeated until no more extension is observed when the spring is released.

15 The period of the marking etc used on a scale under tension may need to be shorter than those on a non tensioned scale because the scale may stretch. A scale with a finer pitch may therefore be provided for use with this tensioner.

Other tensioner modifications and variants will be apparent to the skilled addressee e.g. the spring 54 may be replaced with a gas operated piston, in which case its preload may come from compression of entrapped gas behind the piston, or from a pressurised supply of gas. In either case the piston can be held back under preload by a restraint mechanism e.g. a pin similar to the pin 52.

CLAIMS

1. An elongate track for holding a measurement scale the track having a channel wherein the track is adapted for attracting magnetically the scale to the channel.
5
2. An elongate track as claimed in claim 1 having magnetic material for attracting the scale to the channel of the track magnetically.
3. An elongate track as claimed in claim 2 wherein the magnetic material is a
10 length of ferrite rubber.
4. An elongate track as claimed in claim 2 wherein the magnetic material is disposed in the channel.
- 15 5. An elongate track as claimed in claim 1 wherein the channel is adapted to hold the scale at scale edge portions only.
6. An elongate track as claimed in claim 1 wherein the track is formed from aluminium and is extruded.
20
7. An elongate track as claimed in claim 1 wherein the track is formed from magnetic ferrite rubber, the rubber having the channel formed therein.
8. A magnetic or magnetisable measurement scale for use with the elongate track
25 of claim 1.
9. Measurement apparatus comprising a measurement scale and an elongate track for holding the scale, the track having a channel wherein the track is adapted for attracting magnetically the scale to the channel.
30

10. Measurement apparatus as claimed in claim 9 further comprising a scale tensioner for tensioning the scale on the track.

11. A measurement scale tensioning device wherein the device includes a
5 preloadable member operable to urge a scale into tension.

12. A measurement scale tensioning device as claimed in claim 11 wherein the preloadable member includes a resilient part and the tensioner includes also a loading part for preloading the member and for releasing the preload.

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13. A measurement scale tensioning device as claimed in claim 12 wherein the loading part includes an eccentric, rotatable to effect the preloading and release of the preload.

15

14. A method for tensioning a measurement scale comprising the steps of:
providing a measurement scale, and scale tensioner;
mounting the scale to a substrate;
securing one end of the scale to the substrate;
preloading the scale tensioner;
20 securing the tensioner to the substrate adjacent the other end of the scale;
releasing the preload in the tensioner to cause a tension in the scale;
securing the said other end of the scale to the substrate whilst maintaining the tension in the scale;
releasing the securement of the tensioner.

25

15. A method for tensioning a measurement scale as claimed in claim 14 further comprising the steps of:

preloading the scale tensioner again;
re-securing the tensioner to the substrate adjacent the said other end of the
30 scale;
releasing the preload in the tensioner;

releasing the securement of the scale at the said other end, thereby allowing further tension in the scale;

re-securing the said other end of the scale to the substrate whilst maintaining the further tension in the scale;

5 releasing the securement of the tensioner, and;

repeating the aforementioned steps of this claim until the scale extends substantially no more on application of the further tension.

16. A method according to claim 14 comprising the step of removing the tensioner
10 from the substrate following securement of the scale at the said other end.

17. A method according to claim 15 comprising the step of removing the tensioner from the substrate following re-securement of the scale at the said other end.

15 18. A method according to claim 14 wherein the step of securing the scale to the substrate includes the provision of a track for holding the scale to the substrate.

ABSTRACT

MEASUREMENT APPARATUS INCLUDING A TRACK FOR A MEASUREMENT SCALE AND APPARATUS FOR TENSIONING THE

5 SCALE

There is disclosed: a measurement scale suitable for use with scale reader for
determining displacement; various tracks all for holding the scale and all having a
channel into which the scale is magnetically attracted; and a scale tensioner which in
10 use tensions the scale in situ by release of a preload, prior to the scale being secured to
a substrate, the tensioner being removable thereafter.

(Figs 12 and 17)

Fig.1.

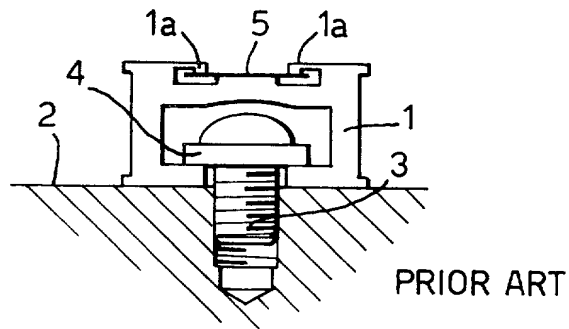


Fig.2.

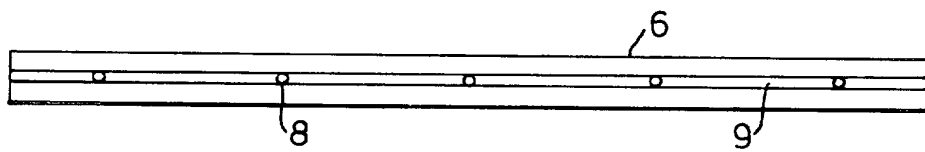


Fig.3.

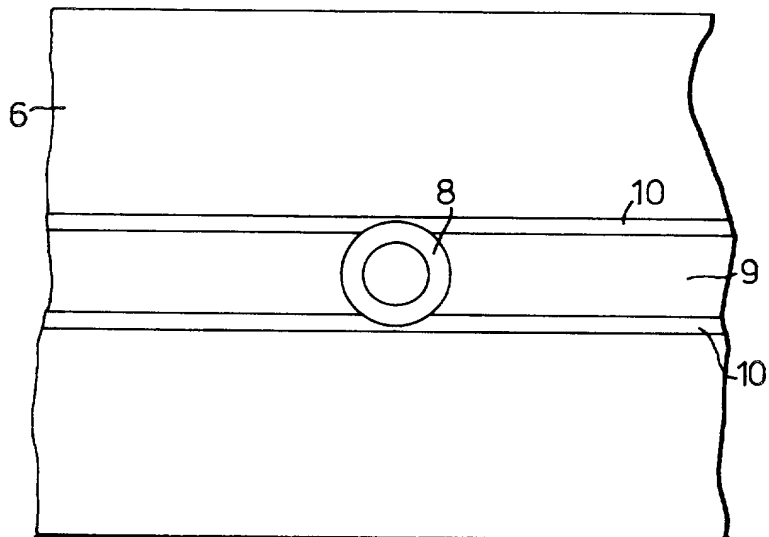


Fig.4.

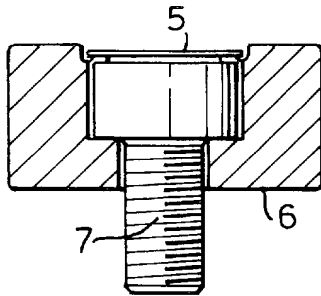


Fig.5.

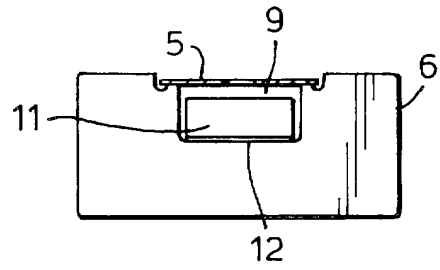


Fig.6.

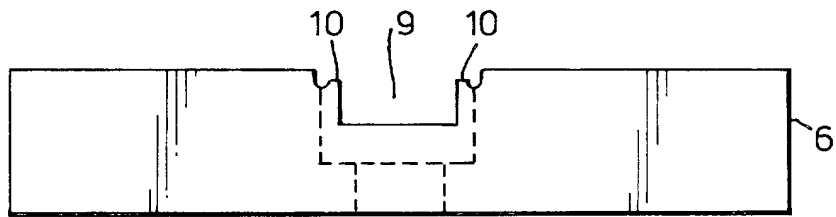


Fig.7.

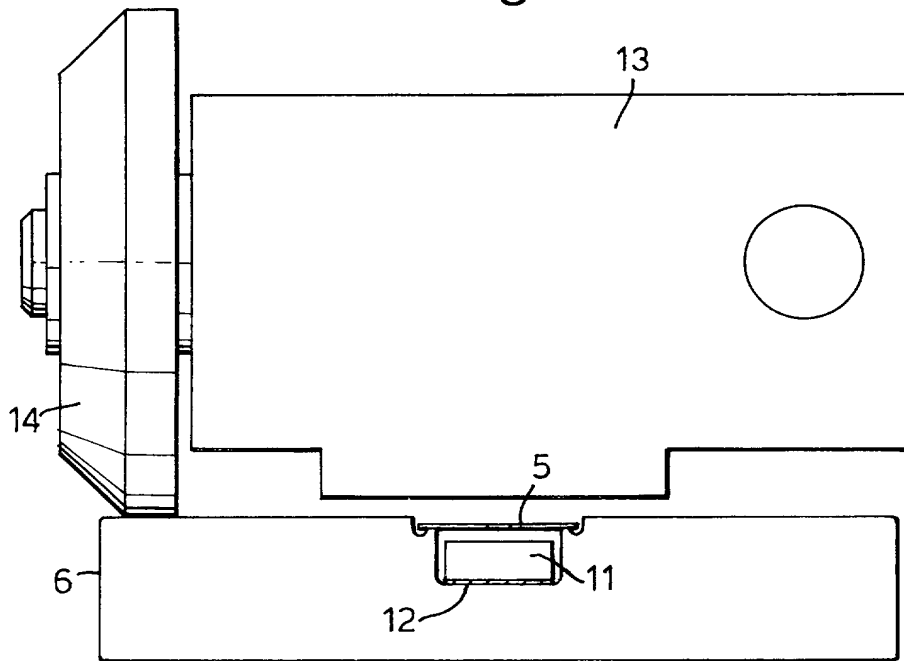


Fig.8.

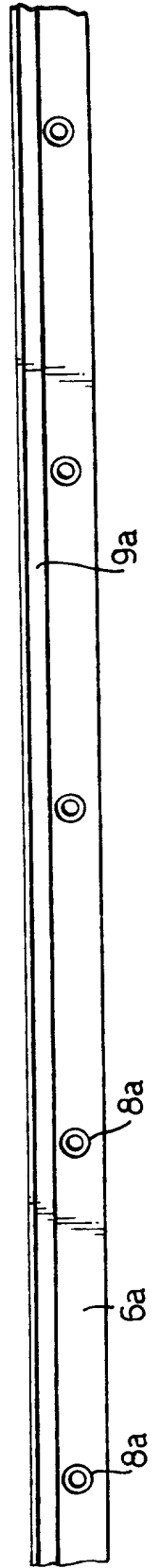


Fig.9.

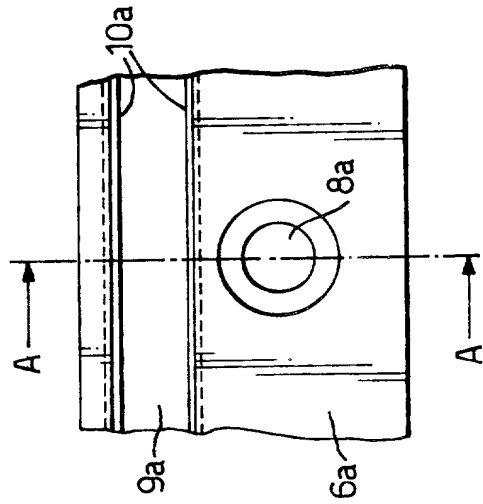


Fig.10(a).

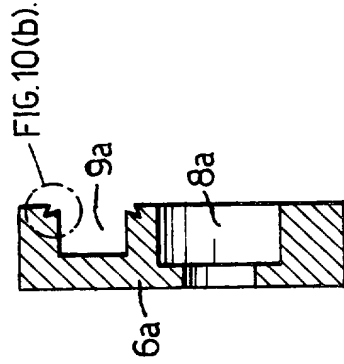


Fig.10(b).

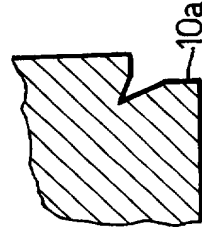


Fig.11.

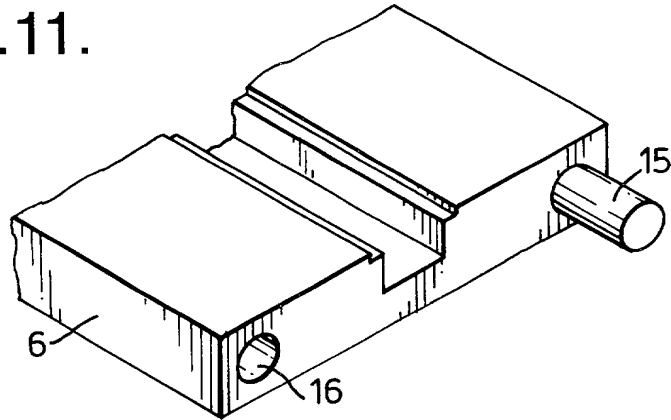


Fig.12.

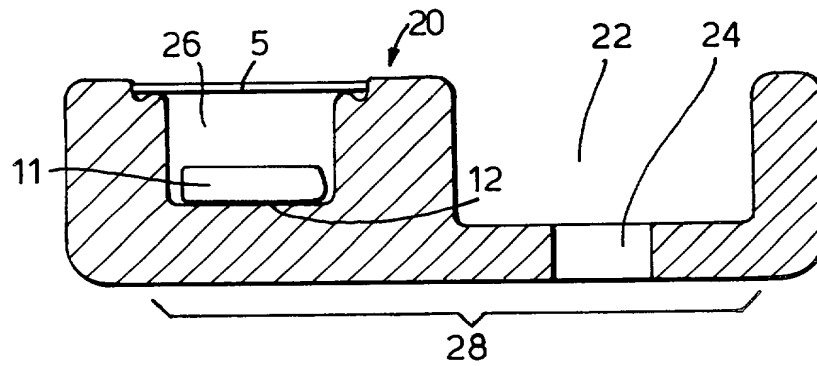


Fig.13.

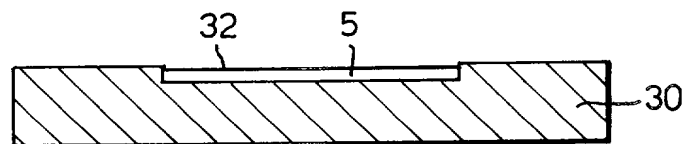


Fig.14.

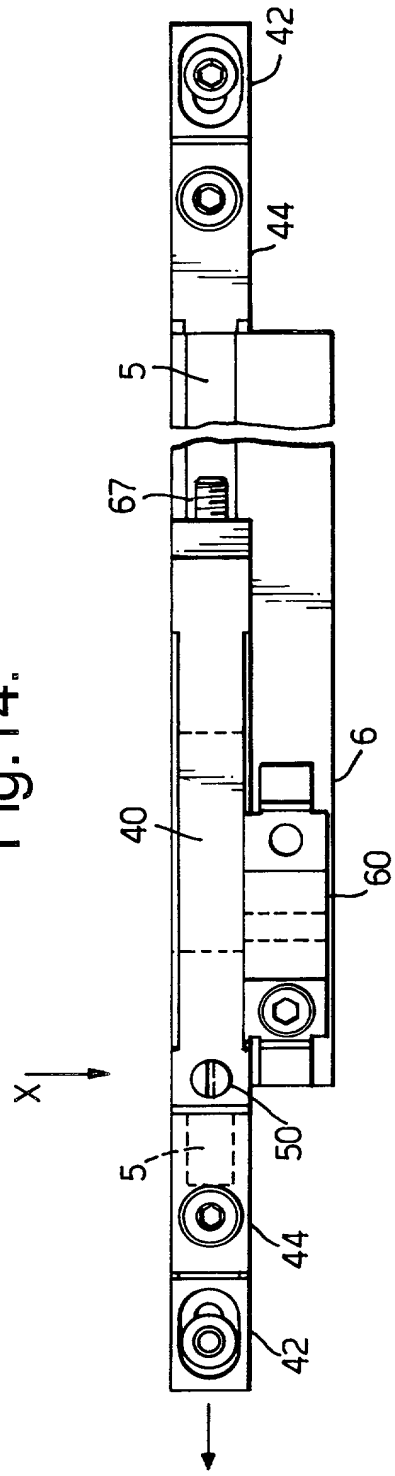


Fig.15.

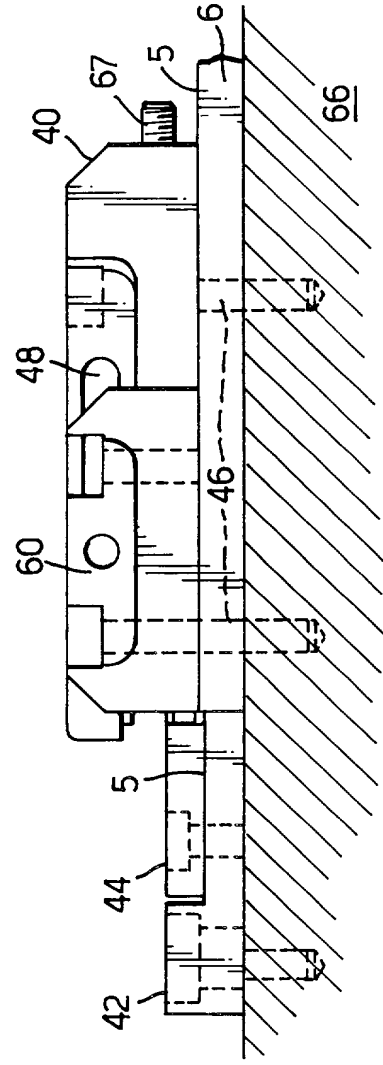


Fig.16.

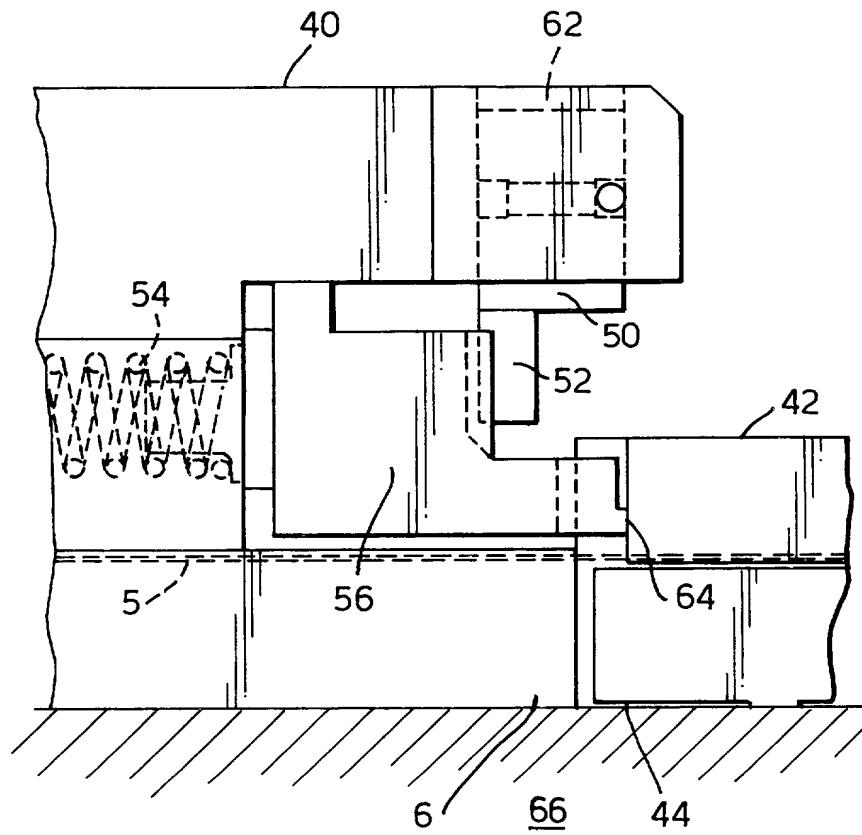
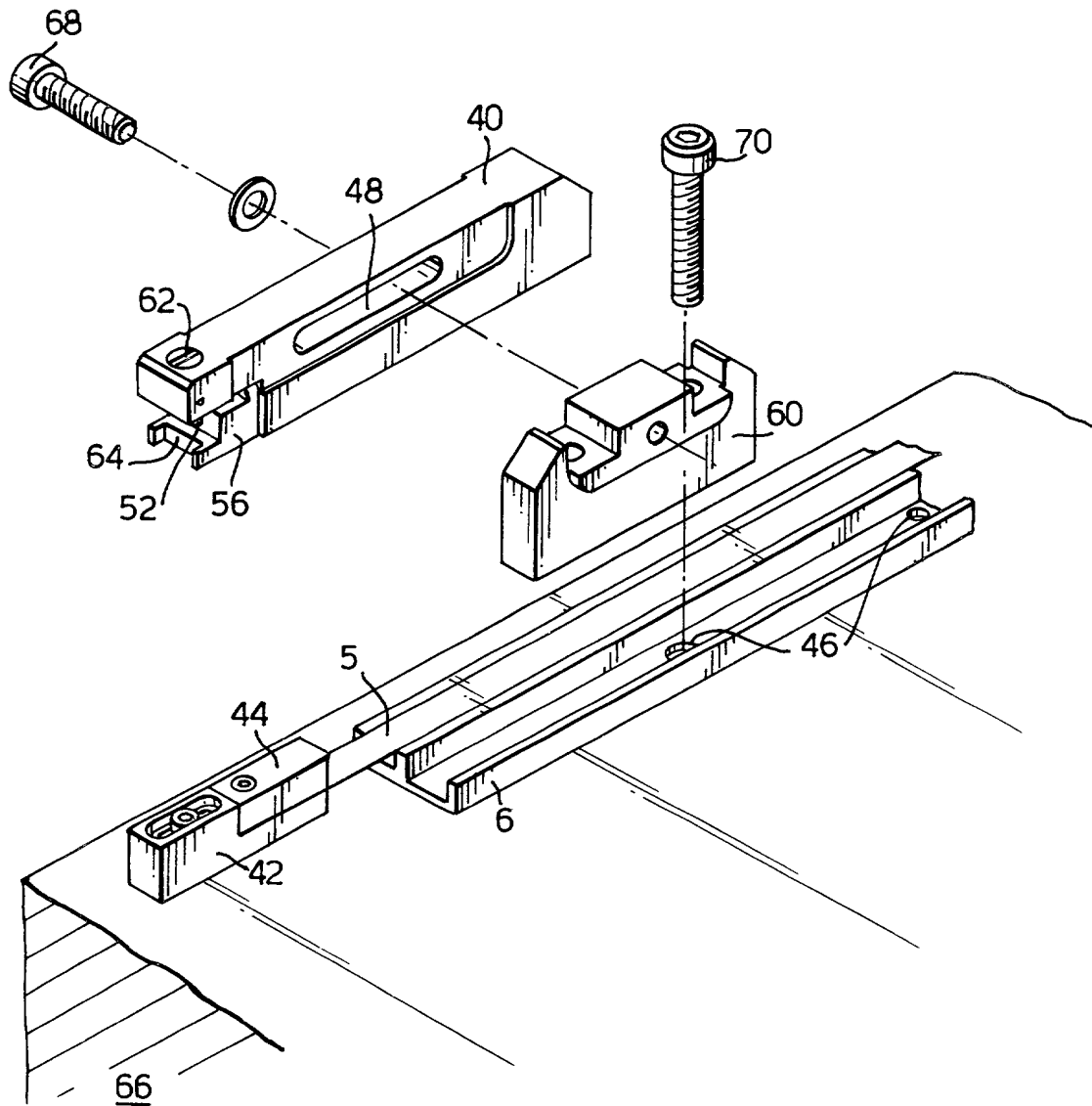


Fig.17.



APPLICATION FOR UNITED STATES PATENT

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: Measurement Apparatus Including A Track For A

1 Measurement Scale And Apparatus For Tensioning The Scale

described and claimed in the specification:

Check one

*a. ☒ attached hereto.

b. ☐ filed on _____ as Application Serial No. _____ and amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information of which I am aware which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). Under Title 35, U.S. Code §119, the priority benefits of the following foreign application(s) filed within one year prior to this application are hereby claimed:

United Kingdom Patent Application NO. 9928098.4 filed 30 November 1999
United Kingdom Patent Application No. 0013141.7 filed 31 May 2000

The following applications for patent or inventor's certificate on this invention were filed in countries foreign to the United States of America either (a) more than one year prior to this application, or (b) before the filing date of the above-named foreign priority application(s):

If there are no corresponding applications,
insert "NONE".

None


I hereby appoint the following as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent Office:


James A. Oliff, Reg. No. 27,075; William P. Berridge, Reg. No. 30,024; Kirk M. Hudson, Reg. No. 27,562;
Thomas J. Pardini, Reg. No. 30,411 and Edward P. Walker, Reg. No. 31,450

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO OLIFF & BERRIDGE, P.O. BOX 19928, ALEXANDRIA, VIRGINIA 22320, TELEPHONE (703) 836-6400.

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

3 Typewritten Full Name of Sole or First Inventor James R Henshaw
Given Name Middle Initial Family Name

**4 Inventor's Signature  James R Henshaw

**5 Date of Signature  Nov 16 2000
Month Day Year

6 Residence Stroud Gloucestershire United Kingdom
City State or Province Country

7 Citizenship United Kingdom

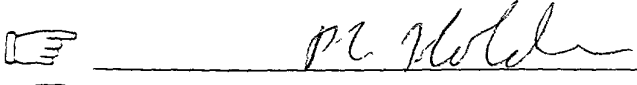
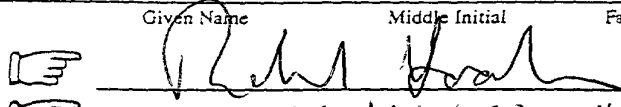
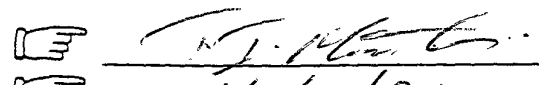
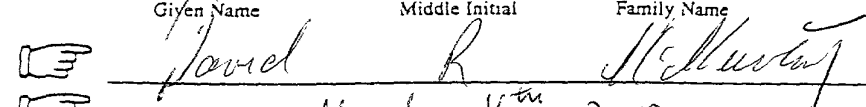
8 Post Office Address 1 Field Place, Paganhill, Stroud,
(Insert complete mailing address, including country) Gloucestershire, GL5 4BB, United Kingdom

*This form may be executed only when attached to the specification (including claims) at the end thereof if Box a. is checked.

**Note to Inventor: Please sign name on line 4 exactly as it appears in line 3 and insert the actual date of signing on line 5.

IF THERE IS MORE THAN ONE INVENTOR USE PAGE 2 AND PLACE AN "X" HERE ☒

PAGE 2 OF U.S.A. DECLARATION FORM
(Discard this page in a sole inventor application)

3	Typewritten Full Name of Second Joint Inventor (if any)	<u>Peter</u>	<u>G</u>	<u>Holden</u>
		Given Name	Middle Initial	Family Name
*4	Inventor's Signature			
*5	Date of Signature	<u>NOVEMBER 16 2000</u>		
		Month	Day	Year
*6	Residence	<u>Cirencester</u>	<u>Gloucestershire</u>	<u>United Kingdom</u>
		City	State or Province	Country
*7	Citizenship	<u>United Kingdom</u>		
8	Post Office Address (Insert complete mailing address, including country)	{ <u>39 Querns Lane, Cirencester,</u> <u>Gloucestershire, GL7 1RL, United Kingdom</u>		
3	Typewritten Full Name of Third Joint Inventor (if any)	<u>Richard</u>	<u>J</u>	<u>Hoodless</u>
		Given Name	Middle Initial	Family Name
*4	Inventor's Signature			
*5	Date of Signature	<u>16 / 11 / 00 November 16th 2000</u>		
		Month	Day	Year
*6	Residence	<u>Bristol</u>	<u>United Kingdom</u>	
		City	State or Province	Country
*7	Citizenship	<u>United Kingdom</u>		
8	Post Office Address (Insert complete mailing address, including country)	{ <u>Flat 2, No. 2, Cambridge Park, Redland,</u> <u>Bristol, BS6 6XN, United Kingdom</u>		
3	Typewritten Full Name of Fourth Joint Inventor (if any)	<u>Thomas</u>	<u>I</u>	<u>Mackintosh</u>
		Given Name	Middle Initial	Family Name
*4	Inventor's Signature			
*5	Date of Signature	<u>16 / 11 / 2000 November 16th 2000</u>		
		Month	Day	Year
*6	Residence	<u>Bristol</u>	<u>United Kingdom</u>	
		City	State or Province	Country
*7	Citizenship	<u>United Kingdom</u>		
8	Post Office Address (Insert complete mailing address, including country)	{ <u>2 Tredegar Road, Fishponds, Bristol,</u> <u>BS16 4BS, United Kingdom</u>		
3	Typewritten Full Name of Fifth Joint Inventor (if any)	<u>David</u>	<u>R</u>	<u>McMurtry</u>
		Given Name	Middle Initial	Family Name
*4	Inventor's Signature			
*5	Date of Signature	<u>November 16th 2000</u>		
		Month	Day	Year
*6	Residence	<u>Wotton-under-Edge</u>	<u>Gloucestershire</u>	<u>United Kingdom</u>
		City	State or Province	Country
*7	Citizenship	<u>Republic of Ireland</u>		
8	Post Office Address (Insert complete mailing address, including country)	{ <u>20 Tabernacle Road, Wotton-under-Edge,</u> <u>Gloucestershire, GL12 7EF, United Kingdom</u>		

*Note to Inventors: Please sign name on line 4 exactly as it appears in line 3 and insert the actual date of signing on line 5
This form may be executed only when attached to the first page of the Declaration and Power of Attorney form and the specification
(including claims) of the application to which it pertains.